CHAPTER

13

South Africa's Tsitsikamma Marine Protected Area — winners and losers

Amanda T. Lombard[a], *Ian Durbach*[b,c], *Jean M. Harris*[a,d], *Judy Mann-Lang*[e], *Bruce Q. Mann*[e], *George M. Branch*[f], *Colin G. Attwood*[f]

[a]Institute for Coastal and Marine Research, Nelson Mandela University, Port Elizabeth, Eastern Cape, South Africa; [b]Department of Statistical Sciences, Centre for Statistics in Ecology, Environment, and Conservation, University of Cape Town, Cape Town, Western Cape, South Africa; [c]African Institute for Mathematical Sciences, Cape Town, Western Cape, South Africa; [d]WILDTRUST, Hilton, KwaZulu-Natal, South Africa; [e]Oceanographic Research Institute, South African Association for Marine Biological Research, Durban, KwaZulu-Natal, South Africa; [f]Department of Biological Sciences, Marine Research Institute, University of Cape Town, Cape Town, Western Cape, South Africa

Abstract

Tsitsikamma National Park on the southern coast of South Africa was proclaimed in 1964, making the marine part of the Park Africa's oldest marine protected area. In 2000 the entire marine area was designated as 'no-take' with extractive harvesting of resources prohibited. This conservation measure, which was aimed primarily at providing a refuge for highly threatened linefish species and recovery of adjacent fisheries through spill-over effects, has been challenged over the years by local anglers. A government decision in 2016 to lift this restriction for shore-angling along 20% of the coastline met significant public and scientific opposition. We explored the different objectives at play (conservation, economic, social and political) and the rationality of this decision using statistical and decision analytic tools that evaluated the decision and alternative options, and their consequences, for each of the objectives. The decision taken performed poorly against many other rational decision options available to government, and resulted in lose-lose outcomes, rather than achievable win-win outcomes.

Keywords:
Evidence-based decision-making; Multi-criteria decision analysis; Wicked problem; Science-policy interface; Public participation process; Stakeholder consultation; Conservation; Threatened fish.

https://doi.org/10.1016/B978-0-08-102698-4.00013-7

Introduction

The Tsitsikamma National Park Marine Protected Area (Tsitsikamma MPA) on the southern coast of South Africa was proclaimed in 1964, making it South Africa's (and Africa's) oldest MPA. As is typical of proclamations in this period, this proclamation, and the subsequent prohibition of extractive resource use implemented in 2000, did not involve a process of full consultation with stakeholders. The 'no-take' status of the Tsitsikamma MPA has been challenged over the years, particularly by local anglers who demanded access and opposed the top-down approach. In 1998, and again in 2007 and 2010, the Ministers then responsible for environmental affairs ruled against challenges to open the MPA to shore angling. In 2015, after years of an escalating polarisation of stakeholders, some for and some against shore angling, the National Government's Department of Environmental Affairs (DEA) gazetted a proposal to open sections of the MPA to recreational shore angling and invited public comment. However, during the comment period, the DEA, without prior notice to stakeholders, opened four sections of the MPA to 'experimental' angling. It reversed this decision after losing in court to a non-governmental organisation that challenged the legality of the action. A year later, in December 2016, this time after receiving comments submitted by stakeholders during the formal stakeholder consultation process, the DEA opened 20% of the MPA's coastline to angling. This decision was taken despite scientific evidence to support maintaining the MPA's 'no-take' status, and significant public support for maintaining the fully protected status of the MPA. This outcome has raised questions about the rationality of the decision, as well as concerns that it was politically motivated and that the decision-making process followed by government was not transparent and ignored the majority of public comments received. Furthermore, reports that local anglers are not satisfied with the size or placement of the opened sections of coast have emerged. The decision taken has also had financial consequences, because the authority tasked with managing these open areas (South African National Parks) required additional funds from National Treasury to monitor compliance in the areas newly opened to anglers and adjacent protected zones. Unfortunately, the long history of poaching in the MPA (Smith et al., 2015), primarily by shore anglers from the adjacent communities, has not been assessed since the December 2016 change in zonation, owing to the necessary aerial surveys not being funded.

Is the Tsitsikamma problem a 'wicked' one (i.e. difficult or impossible to solve, see Skaburskis, 2008)? Was the DEA's solution to the problem the most rational one, based on the information available to them? Were there alternative solutions that could have performed better, for more objectives, and for more stakeholders (not just the local anglers)? We explore the different objectives at play (conservation, economic, social and political) and the rationality of the DEA's decision, using statistical and decision analytic tools that evaluate the alternative decision options and their consequences for each of the objectives.

Evidence-based decision-making

Fisheries science has benefited from other types of evidence-based decision-making processes, particularly those used to evaluate differing management strategies (e.g. Kinas and Andrade, 2007). The frequentist method of modelling environmental responses to management strategies has largely given way to the more powerful Bayesian approach which

quantifies the influence of new information on our plausibility estimates based on existing knowledge (Punt and Hilborn, 1997). This method has been widely used in fisheries for quantifying the effect of competing strategies, against uncertainty in the data (measurement error), and against uncertainty in the way nature works (process error), represented as a set of different scenarios each with its own likelihood. The outcome of any candidate management strategy is assessed by comparing its average outcome (weighted by its likelihood) with the outcomes of other scenarios. In this way the robustness of each candidate strategy to a range of uncertainties, in both measurements and processes, can be evaluated. Bayesian analysis permits a range of qualitative and quantitative data into the decision-making process.

Evidence-based decision-making encourages stakeholders to integrate the best available research evidence with their expertise when making decisions (Greenhalgh et al., 2014). A challenge for many conservation decisions is that quantitative evidence (such as required by fisheries science) will typically not be available to all the objectives that are deemed relevant to a decision (think, for example, of an objective like 'minimise social conflict'). This can be a source of discomfort for those more familiar with models that aim to understand and measure a physical system, with the result that objectives that are not easy to quantify in models are sometimes down-weighted or ignored (Gregory et al., 2006). This is unfortunate, because the field of multi-criteria decision analysis (MCDA) provides a set of well-developed and tested tools to both measure performance of elements that are unavoidably subjective, and to compare the performance of actions across all relevant aspects that lead to a decision (see e.g. Belton and Stewart (2002) for an overview of MCDA and Kiker et al. (2005) for a review of environmental applications). MCDA embodies the philosophy of evidence-based practices and applies it to the decision-making process itself.

South Africa's policy commitment to evidence-based decision-making

Section 24 of South Africa's Constitution (RSA, 1996) states that 'Everyone has the right to an environment that is not harmful to their health or well-being', and the right to 'have the environment protected for the benefit of present and future generations, through reasonable legislative and other measures that prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development'. In line with this Constitutional imperative, the DEA published a Research, Development and Evidence Framework in 2012 (DEA, 2012), advocating an 'evidence-based approach to policy-making in order to address the pressing environmental issues of our times.' This document clearly outlines an approach to incorporate research evidence in policy-making in the environmental sector. The policy (and indeed evidence) basis for using a structured, defensible, rigorous and transparent process to solve the Tsitsikamma 'problem' was thus in place for four years before the 2016 decision to open sections of the MPA to shore angling, indicating that the DEA departed from their own policy framework, and suggesting that a pre-determined outcome was envisaged; an outcome that could be questioned if an evidence-based approach was followed.

South Africa's MPAs were declared under a frequently changing series of legal instruments. Tsitsikamma *National Park* was the first to be declared. It was done so by the highest legislative authority in the country in terms of the National Parks Act of 1962. At that time, the stated management objectives of *National Parks* were centred on preservation, scientific

study, and the provision of opportunities for an increasingly city-based populace to view wildlife – objectives that had not changed since 1913 (Carruthers, 1989). Although this South African *National Park* was a novelty, locally and abroad, its purpose was not differentiated from the many terrestrial parks and reserves already established in the country at that point. The National Parks Act of 1976 specifically included the marine habitat in the ambit of National Parks, but there was no further elaboration on the objectives to accompany the marine extension. The idea to create a *National Park* in the sea stemmed from a discussion held at the first World Parks Congress in Washington in 1962, which pointed to the need for marine conservation areas.

Several *Marine Reserves* were established under the Sea Fisheries Act of 1973 and later 1988, but these legal instruments offered no clearer objective than 'for the protection of fish in general or fish belonging to a particular species or any aquatic plant'. The Sea Fishery Act was replaced with the Marine Living Resources Act of 1998 (MLRA), in the post-1994 democracy. It allowed for the creation of *Marine Protected Areas*, for which objectives were articulated in detail not seen before, including provisions unique to fisheries. Among these were the need to recover depleted stocks, to protect spawner biomass and to reseed adjacent areas. The *Marine Reserves* were carried across to the new Act. Concern that the renaming of *Marine Reserves* to *Marine Protected Areas* in 1998 might create a conflict with *National Parks*, and conversely that existing National Parks legislation might conflict with the new provisions of the MLRA, led to duplicate listings of *National Parks* as MPAs, on the same boundaries and including the same prohibitions of exploitation and development. Tsitsikamma was therefore also a *Marine Protected Area* after 1999.

The National Environmental Management: Protected Areas Act was promulgated in 2003 to consolidate the legislation of protected areas nationwide, although it initially omitted MPAs. All *Marine Protected Areas* were brought under this Act by way of an amendment in 2014, which again articulated a variety of objectives specific to *Marine Protected Areas*, but omitted a clear reference to fisheries management. The omission was politically grounded, following the separation of the ministries managing fisheries and the environment. Fisheries management was now seen as separate from environmental management, a separation that was far clearer in policy than it was in administration.

History of management in the Tsitsikamma Marine Protected Area

The Tsitsikamma MPA forms part of the Tsitsikamma National Park and stretches along approximately 60 km of exposed coastline straddling the Western and Eastern Cape Provinces in southern South Africa. The South African National Parks authority manages the Park, which was included in the Garden Route National Park in 2011. To understand the history of management of the MPA, especially regarding public access to shore angling, a summary of pertinent events is presented in Table 13.1.

The ecological system and threatened fish species

The coastline of the Tsitsikamma MPA is primarily rocky, being at the base of a steep sandstone escarpment, and comprises ideal habitat for many inshore reef fish species (Hanekom et al., 1997). Eight years (1998–2005) of shore-fish monitoring have provided a thorough

TABLE 13.1 A history of management activities in the Tsitsikamma National Park with relevance to recreational shore angling access by members of the public.

Date	Management activity
1964	Proclamation of the Coastal and Forest National Park under the National Parks Act with the seaward boundary of the Marine Protected Area (MPA) at 0.5 nautical miles (0.9 km) offshore between the Groot Rivier (East) and Groot Rivier (West). Originally shore angling was allowed along the entire length of the MPA under permit from South African National Parks (SANParks) (Government Gazette No. 936; Notice 324).
1975	Restriction of shore angling to 15 sites along the western sector of the Park (Government Gazette No. 4237, Notice 61).
1976	Promulgation of the Tsitsikamma Coastal and Forest National Park in terms of the National Parks Act of 1976.
1978	Shore angling limited to a single 3-km section of the Park (start of Otter Trail to the first waterfall). First petition from local anglers (300 signatures) not happy with the restrictions.
1983	Extension of the offshore boundary of the MPA to three nautical miles (5.6 km) (Government Gazette No. 8871, Notice 125), except for the area from the Bloukrans River to Groot Rivier (West) which remained at 0.5 nautical miles (0.9 km) offshore.
1987	De Vasselot Nature Reserve (2561 ha) was added to the coastal Park (Government Gazette No. 11068, Notices 2814 & 2815).
1989	The small Tsitsikamma Forest National Park was deproclaimed in 1989 and the name of the coastal Park became Tsitsikamma National Park (Government Gazette No. 17298, Notice 1077).
1994/5	Petition from the local community (Tsitsikamma Angling Union − 344 signatures) to SANParks to open the entire shoreline to recreational angling. Annual entrance fee reduced from R135 to R10 for local anglers.
1996	The seaward boundary of the De Vasselot section was extended 0.5 nautical miles (0.9 km) offshore (Government Gazette No. 17073, Notice 538).
1998	The Minister responsible for environmental affairs rejects appeals to expand the areas where angling is permitted.
2000	Incorporation of the Tsitsikamma National Park into Section 43 of the Marine Living Resources Act (Act No. 18 of 1998); closure of the last remaining 3-km stretch to shore angling. In December 2000 the marine section of the Park (excluding the marine area off De Vasselot) became the Tsitsikamma National Park Marine Protected Area (Government Gazette No. 21948, Notice 1429). The reasons for the exclusion of the marine area off De Vasselot from the MPA are unclear, but it remains part of the Tsitsikamma National Park.
2006/07	Frustration levels high in the local communities and 70 members forced their way into the Park and fished illegally. Government set up a task team to assess the situation and provide recommendations. At the same time a Statement of Concern was submitted by the marine scientific community (National and International) recommending that the no-take (no angling) status be retained. The then Minister of Environmental Affairs and Tourism rules in favour of maintaining the no-take status.
2008	Publication of the management plan for the Garden Route National Park, including the Tsitsikamma National Park.
2009	The Garden Route National Park (GRNP) was proclaimed on 06 March 2009 (Government Gazette No. 13981, Notice 248).

(*Continued*)

TABLE 13.1 A history of management activities in the Tsitsikamma National Park with relevance to recreational shore angling access by members of the public.—cont'd

Date	Management activity
2010	Further demands by local community for access to shore angling; meetings held between local communities and government. A second Statement of Concern submitted by members of the marine scientific community. Request for recreational angling access denied by the then National Minister of Environmental Affairs.
2011	The Tsitsikamma National Park and Wilderness National Park were included into the GRNP on 11 February 2011 (Government Gazette No. 34017, Notice 95).
2012	Publication of updated management plan for the Garden Route including the Tsitsikamma National Park.
2015	Frustration intensifies within local communities and a task team is set up (headed by the Department of Environmental Affairs (DEA): Oceans and Coasts) to re-assess the situation and re-visit the previous 2006 proposal. Series of meetings held between the Tsitsikamma Angling Union, local municipality, DEA and SANParks.
2015	Publication of government gazette for public comment (Government Gazette No. 39424, Notice 1146) on proposed opening of four controlled zones (20% of coastline) to recreational shore angling exclusively for members of specified local communities living in close proximity to the Tsitsikamma National Park.
2015	Illegal opening by DEA and SANParks of the 'pilot fishery' on 15 December 2015 to recreational shore angling for registered members of the local community.
2016	Closure of 'pilot fishery' in January 2016 as a result of high court decision.
2016	Promulgation of the Tsitsikamma MPA under Section 22A of the National Environmental Management: Protected Areas Act (Act No. 57 of 2003) (Government Gazette No. 40510, Notice 1578). This included the offshore extension of the area from the Bloukrans River to Groot Rivier (West) to three nautical miles (5.6 km) offshore.
2016	Publication of the Regulations for the management of the Tsitsikamma MPA (Government Gazette No. 40511, Notice 1579) in December 2016 which allowed shore angling by registered members of local communities in three zoned areas (approximately 20% of coastline); initiation of catch and effort monitoring by SANParks.

understanding of the inshore fish community in the MPA (Götz et al., 2008). The 25 most-common shore angling species caught within the MPA over this period have been assessed in terms of their distribution, movement, catch composition, population status, IUCN Red Listing and their current listing in terms of the South African Sustainable Seafood Initiative (SASSI) (Fig. 13.1). This showed that 19 (76%) of these species are endemic to South Africa, and 14 (56%) are highly resident and thus well suited for spatial management within MPAs such as the Tsitsikamma MPA (Attwood and Bennett, 1995; Cowley et al., 2002). Ten species have maximum ages in excess of 20 years, highlighting the long period of time that it takes such fish populations to recover after being overexploited. The stocks of 9 species (which comprise 55% of the total catch by number) are overexploited or collapsed within their South African distributions. No-take MPAs such as the Tsitsikamma MPA are therefore vital to ensure the future survival and potential recovery of these fish populations (Attwood et al., 1997). Furthermore, the current optimal status of some linefish species such as roman

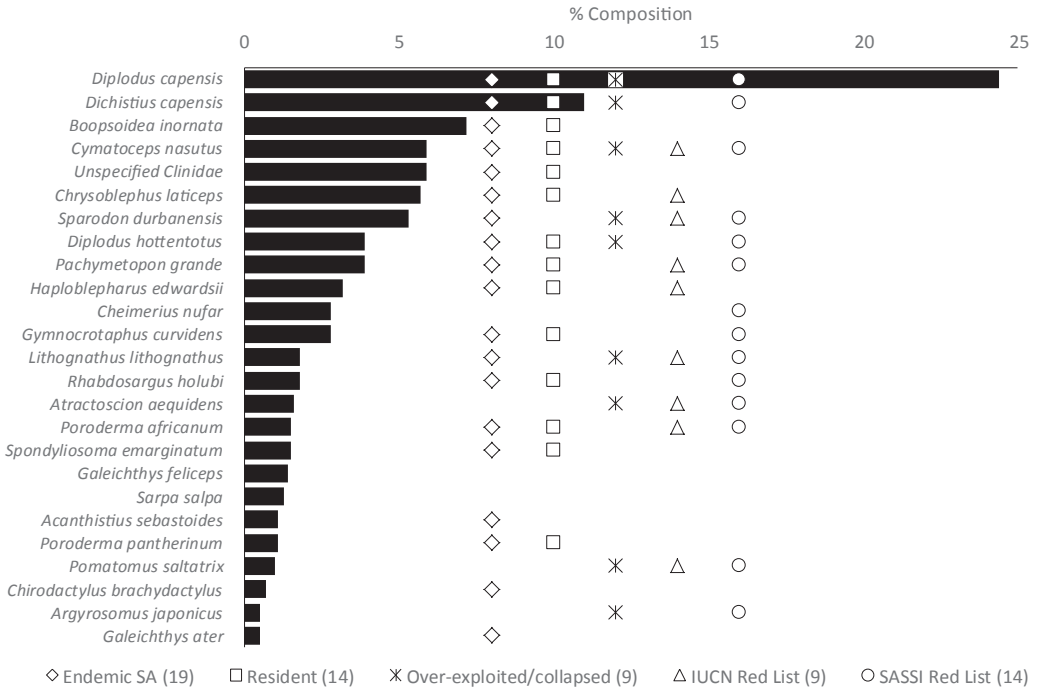

FIG. 13.1 Percentage composition of the top 25 shore angling species caught in the Tsitsikamma National Park based on research angling (Götz et al., 2008). Markers indicate those species endemic to South Africa, resident, over-exploited or collapsed, listed as near-threatened, vulnerable or endangered on the IUCN Red List, or listed as red (to discourage sale) by the South African Sustainable Seafood Initiative. (Numbers in parentheses are the number of species.)

(*Chrysoblephus laticeps*) is primarily thanks to the protection these receive within South Africa's existing network of no-take MPAs including the Tsitsikamma MPA (Kerwath et al., 2008). Nine of the top 25 species (36%) are listed on one of the IUCN's Global Red List of threatened categories (i.e. Near threatened, Vulnerable or Endangered) and highlight the imperative for South Africa's international commitment and obligation to manage these species on a sustainable basis. Fourteen of these species (56%) are listed on the SASSI red list, further emphasising current attempts to increase user and consumer awareness about the depleted status of many of these linefish species (red list species are from unsustainable populations, have extreme environmental concerns, lack appropriate management or are illegal to buy or sell in South Africa). Apart from the fact that they are resident, and therefore susceptible to depletion by local fishing, several of the species that are commonly caught, such as roman and dageraad (*Chrysoblephus cristiceps*) undergo sex change as they age, so that one sex is disproportionately represented in the larger size classes that anglers favour.

Tsitsikamma MPA has been a hot-spot of research demonstrating that MPAs do allow for the protection of linefish and the maintenance of critical spawner biomass. For example Buxton and Smale (1989) showed that roman, dageraad and red steenbras (*Petrus rupestris*) achieved greater abundance and sizes inside the MPA than outside; and Cowley et al.

(2002) recorded that blacktail (*Diplodus capensis*), zebra (*D. hottentotus*), bronze bream (*Pachymetopon grande*) and South Africa's national fish, the galjoen (*Dichistius capensis*) all achieved abundances of 5–21 times more inside the MPA than outside, and that these fish were on average 40% larger in the MPA.

History of stakeholder engagement

Stakeholder engagement has consistently been found to be a key element required for the success of a MPA (Bennett and Dearden, 2014a,b; Dehens and Fanning, 2018; Giakoumi et al., 2018). In the past, stakeholder engagement in the Tsitsikamma MPA was limited to informing the local community of successive closures to shore angling areas. The formation of the Tsitsikamma Angling Forum emanated from the frustration of the local community and resulted in numerous petitions and meetings with SANParks and other officials (Faasen, 2006; Watts and Faasen, 2009). In 1998, 2007 and again in 2010 (Table 13.1) members of the local community, with support from local politicians, attempted to gain angling access to the coast. In all three instances the pleas were rejected by the Environmental Minister of the day, based on the overwhelming scientific evidence provided by the marine science community in South Africa that angling would compromise the MPA's conservation objectives and provide limited relief to anglers.

While Oberholzer et al. (2010) found that the majority (75%) of the local community expressed a favourable attitude towards the Tsitsikamma National Park and considered that it had a positive economic impact on the surrounding area, Faasen (2006) reported that few respondents felt that they had benefited. This discrepancy is likely a result of different sampling methods and underlying research paradigms. Muhl (2016) focussed on the community agitating for angling rights and noted the importance of including their views in decision-making. While superficially, access to angling areas appears to have been the driver behind most of the community demands, a deeper look at the issues reveals a more complex connection between the local community and the shores of Tsitsikamma (Muhl, 2016). The socio-economic characteristics of the different local communities revealed differences in attitudes to the Park, with the local coloured community being the only one adamant that access to fishing was their primary need (Faasen, 2006). This suggests that had meaningful stakeholder engagement taken place far earlier in the process a compromise might have been found that allowed this fishing community access, without significantly compromising the conservation value of the MPA. Furthermore, and inexplicably, the legitimacy of historical access rights claims was not tested by a formal process such as that adopted by government for restitution for people displaced from terrestrial protected areas (the Land Claims Commission) linked to South Africa's colonial and apartheid past. It is also important to note that local residents were not the only community with an interest in the MPA. The community participation process that resulted from the proposed opening of the MPA in 2016 revealed a very broad range of stakeholders concerned about the MPA. This highlights the importance of defining stakeholders broadly as well as the need for different levels of stakeholder engagement. This view was supported by a stakeholder during the public participation process in 2016 who asked 'Why should only one sector of the South African public benefit from this site? It belongs to all of us …. '.

An economic analysis of the Tsitsikamma MPA and other Garden Route MPAs revealed that the recreational value, benefits of 'spill-over' of fish into adjacent areas and 'existence value' amounted to around R800 million annually, far exceeding the costs, which totalled about R450 million (Turpie et al., 2006). But it also showed that opening parts of the MPA to angling would reduce its value, not increase it.

Decision process to date

On the 19 November 2015 the DEA gazetted a proposal to open 20% of the MPA to recreational shore angling exclusively for the adjacent local community. In accordance with South African legislation this was the start of a three-month public participation process. A few weeks later, the public was surprised by an announcement on Facebook that a 'pilot' recreational angling project would start in mid-December 2015. This illegal action contravened a number of South Africa's environmental laws. This prompted the formation of the Friends of Tsitsikamma (FoT), initially comprising ten concerned marine scientists. This group initiated legal action against the government departments responsible for the opening of the MPA to angling. After three High Court appearances the FoT won the case and the pilot fishery was ordered to be terminated with immediate effect in early January 2016.

Throughout the period of the court case the FoT generated awareness amongst the wider South African public about MPAs and the Tsitsikamma MPA in particular. Over a period of less than a month, 100 people joined FoT and over 7600 people signed an online petition initiated by the ORCA Foundation to keep the MPA closed to angling. A large number of media articles were published. The FoT also emphasised the need for the broader public to comment on the proposed rezoning of the MPA, through personal communication, traditional and social media. Concerned citizens were asked to write to the DEA expressing their views. By the closing date of the public participation process (28 February 2016), over 330 comments had been received by the DEA. Of these, over 300 were personally worded letters expressing concern about the proposed opening of sections of the MPA to angling, and the impact that this would have on conservation outcomes and the precedent that would be set by allowing members of the local community exclusive access to harvest fish in a national park for recreational purposes. In addition to individual responses, letters were sent by ten major environmental organisations in South Africa and by many marine scientists. Although almost all of the comments were in favour of maintaining the no-take status of the MPA, some local anglers and local politicians remained adamant that part of the MPA should be opened.

Despite the scientific evidence against opening the MPA and the substantial support from the broader South African public to retain the no-take status of the MPA, in December 2016 the DEA opened 20% of the MPA to recreational shore angling for the local community.

The FoT sent a number of letters to relevant officials in the DEA requesting the rationale for their decision, and offering to participate in a consultative process that might produce preferred options. In February 2017 a formal letter was sent to the DEA, by AfriForum (a national civil rights group), requesting the reasons for the opening of the MPA and information on how the public comments had been addressed during the decision-making process. As the letter was ignored, a request for access to information in terms of the Promotion of Access to Information Act was undertaken. In accordance with the Act the 'request' must be paid for and this was done in June 2017. In July 2017 the DEA responded to the request stating

that 'The requested information (how the public comments were handled) was previously requested through a letter dated 23 February 2017 that was addressed to the Minister of Environmental Affairs. Given the fact that the Department is in the process of responding to the said letter, I have decided to defer giving access to information …. ' However, a document detailing the DEA's rationale for the opening of the Tsitsikamma MPA was provided, and was largely based on meeting social needs. To date no explanation has been given by the DEA as to how the stakeholder comments were addressed during the decision-making process.

Evaluation of the process

Three central points emerge from the events leading to the 2016 opening of the MPA to angling. First, South Africa is bound by national and international legislation to act on the best available scientific evidence. But scientific grounds for permitting angling were very weak, and consultation with the scientific community virtually non-existent. Second, the implementation of angling in 2015 short-circuited the period set for comments, contrary to statutory requirements. This was fundamental to the High Court ruling against angling. Third is the issue of the extent to which public comments influenced the final decision.

In opposing angling in the Tsitsikamma MPA, the FoT expressed many concerns, but of focal interest are: (1) the probability that angling would undermine the stated conservation goals of the MPA; (2) the exclusive access for angling proposed for recreational anglers who were members of 'a Tsitsikamma community'; (3) the size, location and number of 'open' areas proposed in the gazette; and (4) the precedent that was set for other protected areas. Some of these concerns were accommodated in the final regulations gazetted in 2016: the number of areas was reduced from four to three (although the total area remained unchanged at about 20%); stricter bag limits were introduced on the fish that could be caught; and the number of anglers registering to be eligible to fish did decrease. However, the fundamental issue of undermining conservation remained unaddressed.

Reservations about the process and the final outcome were what led us to formulate a different process with a greater likelihood of a 'win-win' outcome, as outlined below. Our aim was to demonstrate how multiple objectives can be addressed in a transparent and robust decision-making processes, and we used MCDA to achieve this (additional methods of solving for multiple-objectives in spatial planning are discussed in Lombard et al. (2019)).

Methods

Seven management scenarios

Throughout the history of the MPA, various management (zoning) scenarios have been proposed by different individuals and stakeholder groups. Table 13.2 summarises the most common proposals. Worth noting is that Scenario 1 is the only scenario to invest funds in the community. Significant funds were requested by Park management for additional compliance monitoring and law enforcement in the event of sections of the MPA being opened to angling. Most of the MPA is inaccessible by road, and a significantly increased staff would

TABLE 13.2 Seven management scenarios for the Tsitsikamma Marine Protected Area (MPA) analysed in the multi-criteria decision analysis.

Scenario	Description
1. MPA closed, invest	Keep the whole Tsitsikamma MPA closed to shore angling, and invest funds in the adjacent community (for any scenario that opens sections inside the MPA to shore angling, extra funds are required from National Treasury for additional compliance monitoring and law enforcement).
2. MPA closed	Keep the whole Tsitsikamma MPA closed to shore angling, and do not invest extra funds in the adjacent community. This was the 'status quo as at mid-December 2015' scenario.
3. Open 1 area, add	Open one area inside the MPA to shore angling (20% of the MPA's shoreline). Identify the same length of coastline of similar habitat outside the MPA, and close this to shore angling. Do not invest extra funds in the adjacent community.
4. Open 1 area	Open one area inside the MPA to shore angling (20% of the MPA's shoreline). Do not close any additional areas outside the MPA to angling (as proposed in Scenario 3). Do not invest extra funds in the adjacent community.
5. Open 3 areas, add	Open three areas inside the MPA to shore angling (20% of the MPA's shoreline). Identify the same length of coastline of similar habitat outside the MPA, and close this to shore angling. Do not invest extra funds in the adjacent community.
6. Open 3 areas	Open three areas inside the MPA to shore angling (20% of the MPA's shoreline). Do not close any additional areas outside the MPA to angling (as proposed in Scenario 5). Do not invest extra funds in the adjacent community. This was the scenario implemented by government.
7. MPA open	Open the whole MPA to shore angling. Do not invest extra funds in the adjacent community.

be required to manage 'open areas' within the MPA. Also worth noting is that scenarios 3–5 are based on 20% of the shoreline being opened to angling, simply because Scenario 6 (the one that was implemented in 2016) was based on this percentage. No rationale was provided by government for this 20% choice.

These seven scenarios are evaluated against conservation, economic, social and political objectives in the multi-criteria decision analysis (MCDA) described below.

Structuring the objectives

To avoid biasing the MCDA analysis towards any particular worldview, we defined an overall objective for the analysis based on the United Nations Sustainable Development Goals (UN, 2015). Thirteen of their 17 goals have primary overarching objectives that are environmental, economic, or social (equity), whereas four are cross-cutting objectives (Table 13.3). The three high-level objectives for the MCDA were drawn from Table 13.3, as were the relative weights of these objectives (Table 13.4). For example, equity goals were most numerous and thus contributed 44% towards the final analysis.

Mid-level objectives (and their respective weights) for the MCDA were defined by the authors, based on their own experience, as well as an extensive review of published literature on MPAs (Table 13.4). Low-level objectives, their attributes and relative weights were defined

TABLE 13.3 United Nations Sustainable Development Goals (UN, 2015) classified by primary overarching objective. Goals 3, 6, 7 and 11 have cross-cutting primary objectives.

	Primary overarching objective		
Sustainable development goal	**Environmental**	**Economic**	**Equity**
1: No Poverty			1
2: Zero Hunger			1
3: Good Health and Well-being	1	1	1
4: Quality Education			1
5: Gender Equality			1
6: Clean Water and Sanitation	1	1	1
7: Affordable and Clean Energy	1	1	1
8: Decent Work and Economic Growth		1	
9: Industry, Innovation and Infrastructure		1	
10: Reduced Inequalities			1
11: Sustainable Cities and Communities	1	1	1
12: Responsible Consumption and Production		1	
13: Climate Action	1		
14: Life Below Water	1		
15: Life on Land	1		
16: Peace, Justice and Strong Institutions			1
17: Partnerships for the Goals			1
TOTAL number of goals (and %)	**7 (28%)**	**7 (28%)**	**11 (44%)**

with the same process, and are documented in the Appendices (Tables A1–A3). The actual values used in the MCDA, with estimates of uncertainty, are also shown in the Appendices. We populated the Tables with values for time zero (which corresponds to the 2016 re-zonation), five years after re-zonation (T5), and ten years after re-zonation (T10), to address the effect of lapsed time on the outcomes of any of the seven management scenarios. Finally, the rationale that was used to assign values to each objective is explained in Appendix Table A4. Rationales are provided for minimum, median and maximum possible values only, and final values were allocated on a gradient of 0–100 using these three metrics as a guide.

In a transparent stakeholder-engagement process, the objectives, weights and values used in an analysis need to be co-developed by all stakeholders, and not by the analytical group alone (as is done here). However, the aim of this analysis is to illustrate how structured decision-making (in this case an MDCA approach) can assist in solving seemingly intractable problems, so the focus is on process, rather than the final values used in the analysis.

TABLE 13.4 Objectives (overall, high-level and mid-level) used for the multi-criteria decision analysis, and weights assigned to each objective as percentages (which sum to 100 along each row).

Overall objective	**United Nations Sustainable Development Goals to 'end poverty, protect the planet, and ensure prosperity for all' (UN, 2015); and United Nations blue economy goals for 'improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities' (UN, 2014).**									
High-level objectives	**Environmental resilience: Maximise ocean health and provision of ecosystem services (28%)**		**Economic resilience: Eradicate poverty, create jobs and increase human well-being (28%)**	**Equity (44%)**						
				Maximise social acceptability (30.8%)			**Maximise political gain amongst stakeholders (13.2%)**			
Mid-level objectives	**Prevent ecological scarcities**	**Reduce environ-mental risk**	**Maximise income and minimise cost**	**Customary rights**	**Proximity rights**	**National rights (Constitution)**	**Municipal**	**National**	**Inter-national**	**Party partisan pressure**
Weight (%)	16.8	11.2	28	12.3	6.2	12.3	3.3	3.3	3.3	3.3

Nonetheless, we attempted to bring as much rigour into the analysis as possible, as is reflected by our choice and weighting of objectives (based on Sustainable Development Goals: Table 13.3), our detailed documentation of rationales used to assign values, and our inclusion of an uncertainty estimate for each value.

Multi-criteria decision analysis

Following the 'value function approach' described in Belton and Stewart (2002), we assigned values of between 0 and 100 to score how each of the potential management scenarios performed against a set of objectives, using the 0, 50 and 100 values outlined in Table A4 as a guide. We then weighted the scores using the weights in Table 13.4 and summed the weighted scores for each objective. We then ranked scenarios from most to least preferred on the basis of these weighted scores.

The basic idea behind the value function approach is to evaluate the performance of each scenario against each attribute in terms of how much it is 'valued' by the decision-maker, before combining these evaluations over all attributes using a weighted sum. There are two ways of doing this. In the 'direct assessment' approach, which we use here, the stakeholder is asked to rate each scenario directly on a preference scale of 0–100. In the 'indirect assessment' approach the stakeholder first evaluates scenarios against some underlying attribute that is considered an appropriate performance measure. An attribute might be, for example, the number of jobs created by a scenario. The stakeholder then constructs a so-called 'value function' that transforms these evaluations (a certain number of jobs created, say 100) into a quantity that represents how much the stakeholder *values* different amounts of the attribute (e.g. how much the stakeholder 'values' the creation of 100 jobs, relative to the creation of a different number of jobs).

Whichever way is used to construct them, the use of values is critical because the underlying attribute ('number of jobs created') does not on its own convey any information about stakeholder preferences. For example, a stakeholder may think it non-negotiable that 100 jobs are created, perhaps because they have promised that to their constituents, but see a further increase to 200 jobs created as relatively unimportant. As a weighted sum is being used to assess scenarios, it is crucial that these kinds of value judgments are included.

Once values have been obtained, the overall value of a scenario is given by a simple weighted average of the scenario's value against each attribute, where weights indicate the relative importance of equal-sized changes in value across different attributes. In our case the model is slightly more complicated because we measure performance across different attributes at three different time-points, so that the overall value of alternative i is given by

$$V_i = \sum_{j=1}^{J} \sum_{t=1}^{3} w_{jt} v_{ijt} \tag{13.1}$$

where v_{ijt} is the value of scenario i on criterion j at time-point t, and w_{jt} indicates the relative importance (weighting) of criterion j at time-point t relative to other criteria. Once these overall values have been calculated for each scenario they provide a means of ranking the scenarios from best (highest value) to worst (lowest value).

Given a particular choice for the weights w_{jt} and values v_{ijt}, the overall score of each scenario is easily calculated using the equation above. A common problem, however, is that both weights and values are often *not* precisely known. Weights may be uncertain where it is practically difficult or impossible for a stakeholder to explicitly state their preferences, as is often the case in politically sensitive decisions, or where the decision-maker is unwilling or unable to expend the time and effort required for assessment. Values can be uncertain for the same reasons, but also where it is not clear how a scenario will perform in the future.

One approach in the face of such uncertainties is to simulate a large number of *possible* weights and values, and to substitute these simulated weights and values into the aggregation equation

$$V_i = \sum_{j=1}^{J} \sum_{t=1}^{3} w_{jt} v_{ijt} \tag{13.2}$$

(stochastic multi-criteria acceptability analysis, see e.g. Lahdelma and Salminen (1998)). For each simulated set of weights and values, this gives a ranking of scenarios. Over all simulations, this gives two useful pieces of information:

1. *Acceptability indices.* The rank r acceptability index measures the proportion of all preferences (i.e. simulation runs) in which management scenario i obtained rank r. In most cases attention is focused on the rank-1 (best) acceptability index, which indicates the proportion of simulations in which each scenario was the most preferred. If a scenario obtains a rank-1 acceptability index of 80%, for example, this means that the scenario was preferred to all other scenarios in 80% of all simulations. In some cases it may be useful to consider other 'good' ranks, such as the proportion of simulations each scenario was ranked second- or third-best. Better scenarios will tend to be favoured by a greater proportion (or at least some) of the simulation runs i.e. to have high acceptability indices for the best ranks.
2. *Central preference vectors.* Unless the decision is trivial and one scenario dominates the others, most scenarios will be chosen as 'best' by *some* combinations of preferences. In this case it is often useful to summarise the kinds of preferences that support each scenario. The central preference vector for scenario i is the average of all preferences in which scenario i came out as 'best'. The central preference vector gives a concise description of the typical preferences supporting the selection of that scenario, with the aim of helping decision-makers understand how different preferences correspond to different choices.

To show how uncertainty can be incorporated into the decision process we performed three illustrative analyses to demonstrate the sensitivity of outcomes to differences in certainty:

1. The performance values of scenarios and the relative importance weights are known with certainty.
2. Performance values are known precisely but relative importance weights are uncertain.
3. Performance values and weights are both uncertain.

TABLE 13.5 Conversion of qualitative descriptions of certainty relating to performance measurement into quantitative bounds.

	Time frame		
Certainty	**Now**	**Five years**	**Ten years**
High	[−5, 5]	[−10, 10]	[−15, 15]
Medium	[−10, 10]	[−20, 20]	[−30, 30]
Low	[−20, 20]	[−40, 40]	[−60, 60]

Values in the table indicate the upper and lower bounds of uniform distributions used to model uncertain performance assessments. Values generated from these uniform distributions are added to the original assessments in Tables A1−A3.

For case (1) above, we used the values and weights reported in Tables A1−A3. The relative weighting of criteria remained unchanged across time-points but the weights of each criterion were decreased over time to reflect discounting for the future. We used a discount rate of 6% but our results are robust over a wide range of realistic discount rates.

For cases (2) and (3), appropriate probability distributions for modelling uncertainty in the performance evaluations and weights would usually be assessed by stakeholders, using a facilitated decision-making process. In the absence of this, we assumed total ignorance about criterion weights by simulating weights uniformly between zero and one, provided the weights summed to one across criteria. Uncertain values were simulated in two ways. In the first, we generated these from a uniform distribution centred on the assessments reported in Tables A1−A3 and with a range given by first classifying each measurement's certainty as 'low, medium or high' and then converting these descriptions into values using Table 13.5. For example, if an evaluation at $t = 0$ was assessed to be 80 with 'medium' certainty, then in each simulation we generated a value from a uniform distribution between 70 (i.e., 80−10) and 90 (i.e., 80 + 10), and use this value to represent the performance of the scenario.

We used the same uncertainty value above and below our best estimates, indicating our belief that the 'upside' and 'downside' risks of the management scenarios are roughly the same. That is, we use uncertainty to acknowledge that our estimates are likely to be too low or too high, but we think that they are likely to be too low or too high by similar magnitudes. Symmetric uncertainty values, although they reflect our best assessments, rarely cause dramatic changes in the ranking of scenarios, because 'on average' evaluations remain the same. To test the effect of asymmetric uncertainty, and at the same time to address the potential objection that we have taken an excessively negative view of opening the MPA, we also conducted an analysis that generated uncertainties so as to favour scenarios that open parts of the MPA to angling. For these scenarios, we generated only positive uncertainties i.e. uncertainties that improved the baseline assessments (thus spanning from 80 to 80 + 10 in the example provided), while for the two scenarios that keep the MPA closed we generated only negative uncertainties (spanning 80 to 80−10). This amounted to respectively replacing the lower and upper bounds in Table 13.5 with zero. Following the introduction of uncertainty, the values were re-standardised within each criterion to lie between 0 and 100. Our main point is not to argue that any particular set of assessments is 'correct', but rather to emphasise that uncertainties should be assessed through a facilitated dialogue

with stakeholders, and to illustrate that the impact of any uncertainties on the final choice of scenario can be assessed in a rigorous, transparent way.

Results

Performance values and weights are known with certainty

Assuming the performance values and weights reported in Tables A1–A3, the option to keep the Tsitsikamma MPA closed to angling and to invest elsewhere the estimated compliance costs that would have been involved in monitoring and policing the angling is clearly preferred at each one of the three time horizons we consider (Table 13.6). Management scenarios that open the MPA can be attractive initially (Open-1-add, Open-1) but these never attain the top rank and perform relatively poorly in later time horizons. The decision that was taken, Open-3, performs second-worst in all three time horizons. The worst scenario would have been to open the entire MPA to angling (MPA-open).

To a large extent the values in Table 13.6 reflect the values and weights we assessed for the various scenarios – the mathematical aggregation of these is a trivial operation. Our point is not so much to say that *our* values and weights are the 'correct' ones, and thus that a different management scenario should have been chosen, but to argue that *some* rational decision-making process should have been followed that is in principle able to generate some consensus on what these numbers might be. Clearly, whatever these numbers might be, they would need to be radically different from our assessments in order for the Open-3 option to be the preferred one.

As the rank order of management scenarios is similar in each time horizon, the overall rankings of scenarios after aggregating over time horizons is not sensitive to the discount rate used (Table 13.7). Scenarios closing the MPA to angling are more preferred than those that keep the MPA open to angling.

Known performance values, uncertain weights

Nearly all simulated weights supported the selection of MPA-closed-invest as the preferred scenario, while the only other scenario leaving the MPA closed was the second-most preferred scenario for just less than 75% of simulated weights (Fig. 13.2). Scenarios opening one area in the MPA (Open-1-add and Open-1) attained second or third ranks in

TABLE 13.6 Value scores for each management scenario at each of the three time horizons.

	MPA-closed-invest	MPA-closed	Open-1-add	Open-1	Open-3-add	Open-3	MPA-open
Now	78	69	70	66	59	56	53
5 years	77	69	62	54	45	40	33
10 years	77	69	58	50	42	35	30

Open-3 was the scenario implemented by government.

TABLE 13.7 Overall value scores for each management scenario, aggregated over time horizons using different discount rates.

Discounting	MPA-closed-invest	MPA-closed	Open-1-add	Open-1	Open-3-add	Open-3	MPA-open
None	77	69	64	57	49	44	39
6%	78	69	65	58	50	46	41
10%	78	69	66	60	52	47	43

Open-3 was the scenario implemented by government.

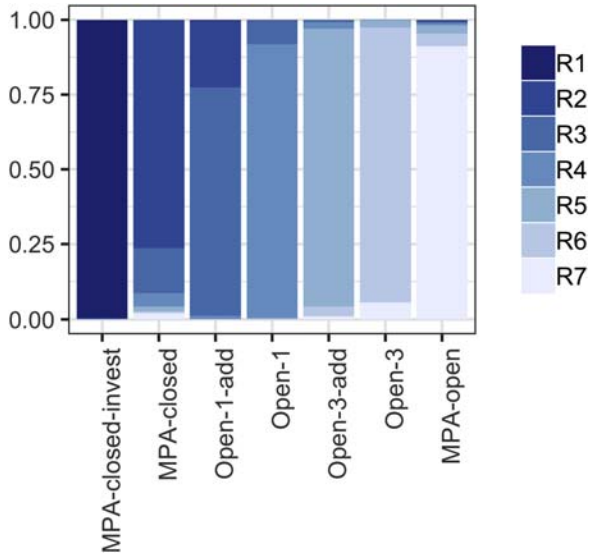

FIG. 13.2 Management scenario acceptability indices under the assumption of known performance evaluations. These show the proportion of simulated weights in which each scenario obtained a particular rank (R1 = best, R7 = worst).

a reasonable proportion of simulations (20% of weights placed Open-1-add in second position), indicating some support. Scenarios that open three or more areas in the MPA achieved good ranks in only a very small proportion of simulations (less than 1%).

Some caution is needed when interpreting the acceptability indices shown in Fig. 13.2. The scenario with the largest acceptability is not necessarily the preferred scenario, and a scenario that is supported by only one set of weights can still be preferred, if those weights happen to represent the decision-maker's actual preferences. The proportion of simulated weights that support a scenario is best interpreted as the range of possible preferences that would still lead to the selection of that scenario. Thus, the fact that the overwhelming majority of preferences lead to the selection of MPA-closed-invest, and also to the ranking of MPA-open in last place, indicates that — in the absence of more information about the kinds of preferences that stakeholders actually have — these choices would be typical of a wide variety of potential

stakeholders. It also indicates that the relative weighting of objectives is probably not a critical input to the decision process, since most weights return the same scenario as preferred. In highly politicised contexts this can be a useful result because it allows for progress to be made towards a decision without having to find consensus on a common set of weights. Different stakeholders may prioritise different objectives, but this will still lead to the selection of the same management scenario. Clearly then, the good performance of the scenarios closing the MPAs is a result of the performance values that are assigned to the individual objectives, rather than on how these objectives are weighted. In the next section we investigate how sensitive results are to relaxing this assumption as well.

Uncertain performance values and uncertain weights

An initial set of simulations in which we generated performance values from uniform distributions centered on the values in Tables A1–A3 returned essentially the same results as in Fig. 13.2, and are therefore not repeated here. Scenarios involving the MPA remaining closed were judged to be less uncertain than those opening either one or three areas inside the MPA, but this uncertainty was not sufficient to allow the latter scenarios to gain greater acceptability. When uncertainties were generated in such a way that they could only improve the performance of scenarios opening parts of the MPA to angling, and worsen the performance of those keeping the MPA closed, a significant minority of preferences (some 20% of preferences) supported the selection of the Open-1-add scenario, although the majority of preferences (80%) continued to support the MPA-closed-invest scenario (Fig. 13.3). While the attractiveness of the Open-1 management scenarios in particular improved as a result of

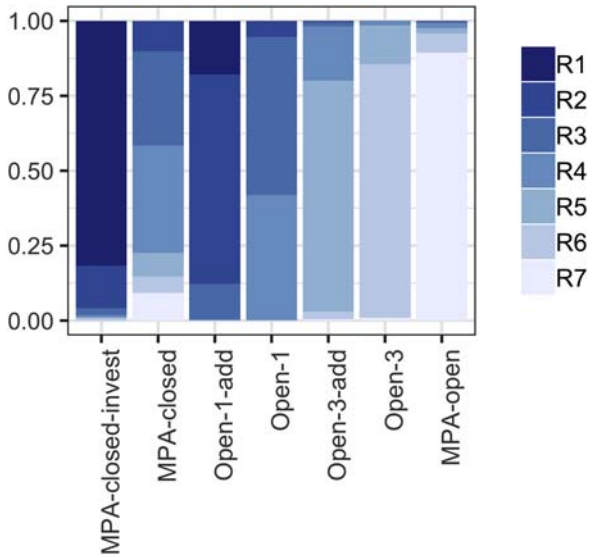

FIG. 13.3 Management scenario acceptability indices when performance evaluations are also uncertain. These show the proportion of simulated weights in which each scenario obtained a particular rank (R1 = best, R7 = worst).

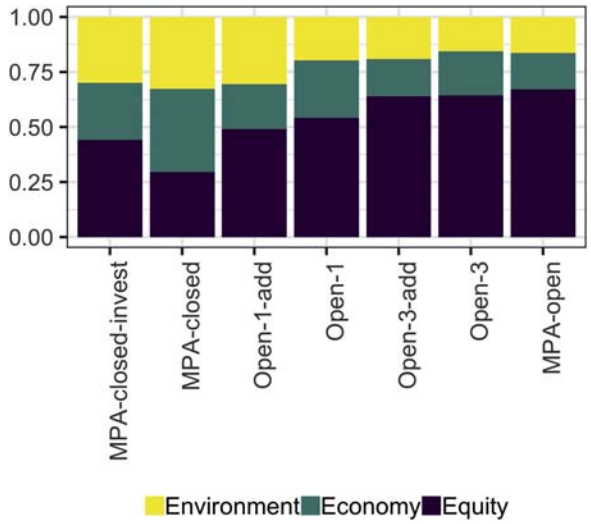

FIG. 13.4 'Average' preferences that would lead to a scenario being selected as best. These are computed as the centroid of all weight combinations that support the selection of a particular scenario. Objectives have been grouped according to high-level classification (environmental, economic, equity) to facilitate visual inspection.

the introduction of this asymmetric uncertainty, the MPA-open scenario remained unattractive, largely because its evaluations were mostly assessed to be at a 'low' level of uncertainty.

Apart from simply counting the number of simulated weights that support each management scenario, the simulation-based approach also allows one to store a set of weights and interrogate them further. In particular, by examining the weights that lead to the selection of a scenario, we get an insight into the kinds of preferences (and hence, the kind of decision-maker) that would select that scenario. Fig. 13.4 shows, for each scenario, the criterion-wise averages of all weight combinations that support that scenario. The fact that these averages exist for each scenario indicates that each scenario is selected as 'best' by at least one combination of weights, even if this is not visible from Fig. 13.3. Preferences that place more weight on equity objectives and less weight on economic objectives tend to favour the selection of the Open-1-add scenario, while those that distribute importance more evenly between the objectives favour the selection of the MPA-closed scenarios (Fig. 13.4). Scenarios that open three or more areas are only preferred if equity objectives are very heavily favoured. The averages in Fig. 13.4 do not tell the whole story, because they do not convey the range of weights that support each scenario, but they do provide a means of conveying to decision-makers the kinds of preferences that support each scenario.

Discussion

There are many lessons that can be learnt from this exercise. The first is that good policies do not translate into good actions unless (a) the polices are actually complied with; (b) the best available scientific information is employed in making decisions, including that derived from natural, economic and social sciences, so that actions are based on evidence; (c) best practices of consultation and co-operation are applied, and (d) legal requirements for public consultation and feedback are not only respected but are acted on to revise and improve proposals.

In the present case, a key factor was the existence of an independent judiciary that could pass a judgement on the legality of the actions of DEA in enacting fishing before due consultation with the public had taken place. The court ruling upheld the requirement for government departments to invite comments, to allow sufficient time for this to take place, and to react to comments in a way that allows incorporation of alternative suggestions as far as possible. In this requirement, the present process was flawed. Implementation of legislation took place before the period of comment had even passed. Even when angling was halted to allow comments to be submitted, there was never any consultation, and revision of the regulations for proposed angling was minimal – amounting to the reduction of the number of angling areas from four to three, and to some tightening of regulations concerning numbers of fish that could be caught. Moreover, the views of the scientific community outside of the government officials involved with the negotiations were never sought, either before or after the gazette was passed, despite efforts by both individuals and representative bodies to facilitate this. The result has left all parties dissatisfied: anglers still complain; managers have to implement additional measures without additional funding and staff; scientists feel undervalued; and conservation is compromised.

It is against this backdrop that we propose a procedure that could have avoided many of the pitfalls. The multi-criteria decision analysis (MCDA) that we advance in this paper can help overcome many of these. Its very name demands that multiple criteria, often cutting across economic, social and environmental divides, must be considered. It demands that knowledge from all interested parties – whether they be anglers, politicians, managers, economists, sociologists or natural scientists – is incorporated in the process. It requires acceptance of objectives, and agreement on how these objectives can be measured and the degree to which they are being fulfilled. It needs joint thought on how these measures should be weighted. All of this distils to a powerful process of consultation and co-operation. It can yield measures that can be documented and rationally defended.

In outlining the process here, we have been at pains to emphasise that this is a process, not a final outcome. Our simulations are just that: they demonstrate the power of the process but not a final outcome. For fruition, it needs inputs from all interested persons who can agree on alternative scenarios, decide the criteria needed to measure their relative benefits, and secure consensus on the weighting of different measures. The process itself compels consultation, involves divergent views, and makes people feel part of the outcome, rather than being invited to pass comment after the event (a problem discussed in detail by Flannery et al., 2018). It also yields an objective outcome, and the grounds for the outcome are transparent and accessible so they can be challenged.

Despite our exercise being a simulation, we believe that the conclusions are robust because we conducted a number of sensitivity tests to see if the conclusions would change. Under all circumstances examined, the option 'MPA-closed-invest' scored best, and the 'MPA-open' option scored worst, establishing confidence that this overall result is unlikely to change. Nevertheless, this is clearly a first step only, and the multi-criteria decision analysis (MCDA) needs to be run with values and weights derived from a consultative process in which all stakeholders discuss and agree on the most appropriate inputs. In this sense, we offer the procedure as a way forward that will incorporate all parties, insure involvement, generate discussion and lead to resolutions that are defendable and based on defined criteria and values. In short, ours is a procedure, not a final set of solutions. It needs to be applied, not blindly accepted.

History has proven that the application of evidence-based and consultative processes are powerful means of overcoming problems. So, for example, an intensive evidence-based approach led by the DEA culminated in a successful management strategy for elephants in the Kruger National Park (Scholes and Mennell, 2008), ending years of heated debate regarding the effectiveness, and ethics, of culling interventions to reduce elephant impacts on vegetation.

Conclusions

In the Introduction we posed a series of questions that prompted the application of a Multiple Criteria Decision Analysis (MCDA).

1. Is the Tsitsikamma problem a 'wicked' one (i.e. difficult or impossible to solve)? In one sense it is a difficult problem to solve because it pits opposing views against each other, and it addresses an issue that has national ramifications because national parks are 'national', but the issue of fishing rights has been treated as one that is local. It is also difficult because local interest groups brought to bear political pressure based on historical injustices. But despite these overarching issues, that does not make the problem 'wicked' in the sense that it cannot be resolved. Use of an MCDA would have compelled consultation and interaction with a broader set of participants, examination of a wider array of options, and critical examination of their merits (values) and their relative importance (weights). We are confident it would have yielded a better outcome.
2. Did the DEA reach a rational solution based on the best scientific information available to them, or are all stakeholders 'losers'? We believe that while their solution addressed the immediate problem of local social and economic pressures to open parts of the MPA to angling, it did not incorporate 'best available scientific advice'. Indeed, it was a prominent feature of the process that scientists felt undervalued. Clearly, not all stakeholders emerged as 'losers', as local communities did gain some access to angling. But whether that approached an optimal or sustainable long-term solution is doubtful. Certainly conservation, one of stated goals of the Tsitsikamma MPA, emerged as a 'loser'.

3. Were there alternative solutions that could have performed better, for most objectives or for more stakeholders, not just the local anglers but the wider community? Almost certainly. The size, position and number of 'open' areas were all subject to challenge and alternatives existed. The communities of people eligible for fishing was also a point of contention. Restitution of the rights of historically disadvantaged local people denied access is a clear goal of the country's Constitution. But extending to people's rights to fish recreationally in the Tsitsikamma MPA simply because they live adjacent or near to the MPA creates an ominous precedent. These are all points that go way beyond our MCDA, but there is no reason in principle why that could not have formed part of it.

We conclude that the Tsitsikamma problem is not 'wicked' in the sense of it being insoluble, but that many alternative decision scenarios perform better for a number of objectives than the decision that was implemented, and better outcomes could have been achieved for the local anglers, and that many more stakeholders could have been 'winners'. We advocate that, in future, such a rigorous, meaningful and transparent multi-stakeholder consultative approach be applied to decisions regarding the management of South Africa's MPAs and, indeed, other environmental issues that need conflict resolution.

References

Attwood, C.G., Bennett, B.A., 1995. Modelling the effect of marine reserves on the recreational shore-fishery of the south-western Cape, South Africa. South African Journal of Marine Science 16 (1), 227–240.

Attwood, C.G., Mann, B.Q., Harris, J.M., 1997. Review of the state of marine protected areas in South Africa. African Journal of Marine Science 18, 341–367.

Belton, V., Stewart, T., 2002. Multiple Criteria Decision Analysis: An Integrated Approach. Kluwer Academic Publishers, Boston.

Bennett, N.J., Dearden, P., 2014a. Why local people do not support conservation: community perceptions of marine protected area livelihood impacts, governance and management in Thailand. Marine Policy 44, 107–116.

Bennett, N.J., Dearden, P., 2014b. From measuring outcomes to providing inputs: governance, management, and local development for more effective marine protected areas. Marine Policy 50, 96–110.

Buxton, C.D., Smale, M.J., 1989. Abundance and distribution patterns of three temperate marine reef fish (Teleostei: Sparidae) in exploited and unexploited areas off the southern Cape coast. Journal of Applied Ecology 26, 441–451.

Carruthers, J., 1989. Creating a national park, 1910 to 1926. Journal of Southern African Studies 15 (2), 188–216.

Cowley, P.D., Brouwer, S.L., Tilney, R.L., 2002. The role of the Tsitsikamma National Park in the management of four shore-angling fish along the south-eastern Cape coast of South Africa. South African Journal of Marine Science 24 (1), 27–35.

DEA (Department of Environmental Affairs), 2012. Environment Sector Research, Development and Evidence Framework: An Approach to Enhance Science-Policy Interface and Evidence-Based Policy Making. Department of Environmental Affairs, Republic of South Africa, Pretoria.

Dehens, L.A., Fanning, L.M., 2018. What counts in making marine protected areas (MPAs) count? The role of legitimacy in MPA success in Canada. Ecological Indicators 86, 45–57.

Faasen, H., 2006. Synergies between Biodiversity Conservation and Sustainable Rural Development of Adjacent Communities: A Case Study of the Tsitsikamma National Park (Doctoral dissertation). University of Stellenbosch.

Flannery, W., Healy, N., Luna, M., 2018. Exclusion and non-participation in marine spatial planning. Marine Policy 88, 32–40.

Giakoumi, S., McGowan, J., Mills, M., Beger, M., Bustamante, R., Charles, A., Christie, P., Fox, M., Garcia Borboroglu, P., Gelcich, S., Guidetti, P., 2018. Revisiting "success" and "failure" of marine protected areas: a conservation scientist perspective. Frontiers in Marine Science 5 article 223.

Götz, A., Cowley, P.D., Winker, H., 2008. Selected fishery and population parameters of eight shore-angling species in the Tsitsikamma National Park no-take marine reserve. African Journal of Marine Science 30 (3), 519–532.

Greenhalgh, T., Howick, J., Maskrey, N., 2014. Evidence based medicine: a movement in crisis? British Medical Journal 348, 3725.

Gregory, R., Failing, L., Ohlson, D., McDaniels, T.L., 2006. Some pitfalls of an overemphasis on science in environmental risk management decisions. Journal of Risk Research 9 (7), 717–735.

Hanekom, N., Mann-Lang, J.B., Mann, B.Q., Carinus, T.V.Z., 1997. Shore-angling catches in the Tsitsikamma National Park, 1989–1995. Koedoe 40 (2), 37–56.

Kerwath, S.E., Götz, A., Attwood, C.G., Sauer, W.H.H., 2008. The effect of marine protected areas on an exploited population of sex-changing temperate reef fish: an individual-based model. African Journal of Marine Science 30 (2), 337–350.

Kiker, G.A., Bridges, T.S., Varghese, A., Seager, T.P., Linkov, I., 2005. Application of multicriteria decision analysis in environmental decision making. Integrated Environmental Assessment and Management 1 (2), 95–108.

Kinas, P.G., Andrade, H.A., 2007. Bayesian statistics for fishery stock assessment and management: a synthesis. Pan-American Journal of Aquatic Sciences 2 (2), 103–112.

Lahdelma, R., Hokkanen, J., Salminen, P., 1998. SMAA-stochastic multiobjective acceptability analysis. European Journal of Operational Research 106 (1), 137–143.

Lombard, A.T., Ban, N.C., Smith, J.L., Wood, S.A., Lester, S.E., Sink, K.J., Jacob, A.L., Kyriazi, Z., Tingey, R., Sims, H.E., 2019. Practical approaches and advances in spatial tools to achieve multi-objective marine spatial planning. Frontiers in Marine Science 6, 166.

Muhl, E., 2016. Food Security and Livelihoods: Understanding Marine Protected Area Impacts in the Tsitsikamma (B.Sc. Honours thesis). University of Cape, Town, South Africa.

Oberholzer, S., Saayman, M., Saayman, A., Slabbert, E., 2010. The socio-economic impact of Africa's oldest marine park. Koedoe 52 (1), 1–9.

Punt, A.E., Hilborn, R.A.Y., 1997. Fisheries stock assessment and decision analysis: the Bayesian approach. Reviews in Fish Biology and Fisheries 7 (1), 35–63.

RSA (Republic of South Africa), 1996. Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996).

Scholes, R.J., Mennell, K., 2008. Elephant Management: A Scientific Assessment of South Africa. Wits University Press, Johannesburg.

Skaburskis, A., 2008. The origin of "wicked problems". Planning Theory & Practice 9 (2), 277–280.

Smith, M.K.S., Kruger, N., Murray, T.S., 2015. Aerial surveys conducted along the Garden Route coastline, South Africa, to determine patterns in shore fishing effort. Koedoe 57 (1), 1–9.

Turpie, J., Clark, B., Hutchings, K., 2006. The Economic Value of Marine Protected Areas along the Garden Route Coast, South Africa, and Implications of Changes in Size and Management. Report to WWF–SA.

UN (United Nations), 2014. United Nations Blue Economy Concept Paper. https://sustainabledevelopment.un.org/content/documents/2978BEconcept.pdf.

UN (United Nations), 2015. United Nations General Assembly Resolution. Transforming Our World: The 2030 Agenda for Sustainable Development. A/RES/70/1. http://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_70_1_E.pdf.

Watts, S., Faasen, H., 2009. Community-based conflict resolution strategies for sustainable management of the Tsitsikamma National Park, South Africa. South African Geographical Journal 91 (1), 25–37.

Appendix

TABLE A1 Environmental resilience: all objectives and attributes used for the multi-criteria decision analysis, and weights assigned to each objective as percentages (Table 13.4 shows that environmental resilience contributes 28% to the overall objective).

High-level objectives	**Environmental resilience: maximise ocean health and provision of ecosystem services (28%)**																				
Mid-level objectives	**Prevent ecological scarcities (16.8%)**									**Reduce environmental risk (11.2%)**											
Low-level objectives	Protect threatened linefish			Protect intertidal habitats			Provide spill-over			Protect/provide refugia			Provide climate change mitigation			Collapse of species NB to fisheries				
Attributes	*Species abundance (of these spp.)*			*Reduction of intertidal stocks, ecosystem shifts from over-harvesting*			*Relative abundance of target species inside and outside reserve*			*Size and design*			*Cumulative impacts measure/ecosystem health*			*Fisheries measures, spawner biomass (less than 20% = critical)*				
Weights	8.4%			2.8%			5.6%			2.8%			1.4%			7.0%				
Management scenarios	**T0**	**T5**	**T10**	**T0**	**T5**	**T10**	**T0**	**T5**	**T10**	**T0**	**T5**	**T10**	**T0**	**T5**	**T10**	**T0**	**T5**	**T10**			
1. MPA closed, investment	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H
2. MPA closed	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H	100 H
3. Open 1 area, add	100 H	80 H	60 H	100 H	90 H	90 H	100 M	80 M	75 M	90 L	80 L	80 L	90 L	80 L	80 L	90 H	80 H	75 H			
4. Open 1 area	100 H	50 H	40 H	100 H	80 H	80 H	100 M	70 M	60 M	70 L	50 L	50 L	70 L	60 L	60 L	70 H	50 H	40 H			
5. Open 3 areas, add	100 H	40 H	35 H	100 H	70 H	70 H	100 M	50 M	40 M	50 M	40 M	40 M	50 M	40 M	40 M	50 M	40 M	35 M			
6. Open 3 areas	100 H	30 H	20 H	100 H	50 H	50 H	100 M	30 M	20 M	25 M	20 M	20 M	30 M	25 M	25 M	25 M	20 M	15 M			
7. MPA open	100 H	10 H	0 H	100 H	20 H	20 H	100 H	0 H	0 H	0 H	0 H	0 H	0 H	0 H	0 H	0 H	0 H	0 H			

Management scenarios are described in Table 13.2. Values assigned to each management scenario, for each objective, are shown below the weights (T0 = time zero; T5 = T0 + five years; T10 = T0 + 10 years. An H, M or L to the right of each value indicates that the authors assigned a High, Medium or Low certainty to that value).

TABLE A2 Economic resilience: all objectives and attributes used for the multi-criteria decision analysis, and weights assigned to each objective as percentages (Table 13.4 shows that economic resilience contributes 28% to the overall objective).

High-level objectives	**Economic resilience: eradicate poverty, create jobs and increase human well-being (28%)**																													
Mid-level objectives	**Maximise income and minimise cost (28%)**																													
Low-level objectives	Direct income to South African National Parks (SANP)						Direct contribution to livelihoods						Indirect income (local area income via e.g. employment opportunities, trade)						Indirect income (contribute to international tourist revenue i.e. national tax base)						Minimise management/ compliance costs (to SANP)					
Attributes	*Reserve income (entry and accommodation)*						*Offset food protein bill*						*Local economic stats*						*National & SANP economic stats*						*SANP management costs*					
Weights	7.0%						2.8%						5.6%						5.6%						7.0%					
Management scenarios	**T0**		**T5**		**T10**		**T0**		**T5**		**T10**		**T0**		**T5**		**T10**		**T0**		**T5**		**T10**		**T0**		**T5**		**T10**	
1. MPA closed, investment	100	H	80	H	80	H	100	H	100	H	100	H	100	H	100	H	100	H	100	H	100	H	100	H	100	H	100	H	100	H
2. MPA closed	100	H	100	H	100	H	0	H	0	H	0	H	100	H	100	H	100	H	100	H	100	H	100	H	100	H	100	H	100	H
3. Open 1 area, add	90	M	80	M	80	M	70	M	50	M	50	M	50	M	30	M	30	M	90	M	70	M	60	M	50	H	50	H	50	H
4. Open 1 area	90	M	70	M	70	M	70	M	50	M	50	M	40	M	30	M	30	M	90	M	70	M	60	M	70	H	70	H	70	H
5. Open 3 areas, add	70	M	60	M	60	M	80	M	30	M	30	M	30	M	20	M	20	M	70	H	50	H	30	H	20	H	20	H	20	H
6. Open 3 areas	70	M	50	M	50	M	80	M	30	M	30	M	15	M	10	M	10	M	70	H	50	H	30	H	40	H	40	H	40	H
7. MPA open	50	H	30	H	30	H	100	M	20	M	20	M	5	H	0	H	0	H	50	H	25	H	15	H	20	H	20	H	20	H

Management scenarios are described in Table 13.2. Values assigned to each management scenario, for each objective, are shown below the weights (T0 = time zero; T5 = T0 + five years; T10 = T0 + 10 years. An H, M or L to the right of each value indicates that the authors assigned a High, Medium or Low certainty to that value).

TABLE A3 Equity: all objectives and attributes used for the multi-criteria decision analysis, and weights assigned to each as percentages (Table 13.4 shows that equity contributes 44% to the overall objective).

	Equity (44%) (i.e. 30.8% + 13.2%)																													
High-level objectives	**Maximise social acceptability (30.8%)**																													
Mid-level objectives	**Customary rights**						**Proximity rights**						**National rights (Constitution)**																	
Low-level objectives	Restore customary rights of local resource users						Provide access to local recreational anglers						Bill of Rights (Chapter 24)						Evidence-based (knowledge-based) decisions											
Attributes	*Potential to restore traditional rights*						*Potential to achieve this goal*						*Potential to achieve this goal*						*Application of social knowledge of local community*						*Application of scientific knowledge of the resource*					
Weights	12.3%						6.2%						6.2%						3.1%						3.1%					
Management scenarios	**T0**		**T5**		**T10**		**T0**		**T5**		**T10**		**T0**		**T5**		**T10**		**T0**		**T5**		**T10**		**T0**		**T5**		**T10**	
1. MPA closed, investment	0	H	0	H	0	H	0	H	0	H	0	H	100	H	100	H	100	H	70	M	70	M	70	M	100	H	100	H	100	H
2. MPA closed	0	H	0	H	0	H	0	H	0	H	0	H	100	H	100	H	100	H	0	M	0	M	0	M	100	H	100	H	100	H
3. Open 1 area, add	50	M	50	M	50	M	50	H	50	H	50	H	75	M	75	M	75	M	30	L	30	L	30	L	60	H	60	H	60	H
4. Open 1 area	50	M	50	M	50	M	50	H	50	H	50	H	50	M	50	M	50	M	30	L	30	L	30	L	50	H	50	H	50	H
5. Open 3 areas, add	75	M	75	M	75	M	75	H	75	H	75	H	25	M	25	M	25	M	50	L	50	L	50	L	20	M	20	M	20	M
6. Open 3 areas	75	M	75	M	75	M	75	H	75	H	75	H	10	M	10	M	10	M	50	L	50	L	50	L	10	M	10	M	10	M
7. MPA open	100	H	100	H	100	H	100	H	100	H	100	H	0	H	0	H	0	H	25	L	25	L	25	L	0	H	0	H	0	H

	Equity (continued)																							
High-level objectives	**Maximise political gain amongst stakeholders (13.2%)**																							
Mid-level objectives	**Municipal**						**National**						**International**						**Party partisan pressure**					
Low-level objectives	Municipal buy-in and support for the Park						Supporting national goals (buy-in from parliament)						International accolades or negative perception of South Africa						Ruling party leverage in meetings					
Attributes	*Assume that priorities are not environmental*						*Assume priorities for the environment are more important*						*Assume priorities for environment even more important*						*Party-partisan pressure on decision maker*					
Weights	3.3%						3.3%						3.3%						3.3%					
Management scenarios	**T0**		**T5**		**T10**		**T0**		**T5**		**T10**		**T0**		**T5**		**T10**		**T0**		**T5**		**T10**	
1. MPA closed, investment	80	H	80	H	80	H	100	H	100	H	100	H	100	H	100	H	100	H	50	M	50	M	50	M
2. MPA closed	0	H	0	H	0	H	100	M	100	M	100	M	90	H	90	H	90	H	0	H	0	H	0	H
3. Open 1 area, add	20	L	15	L	10	L	80	M	80	M	70	M	70	M	70	M	60	M	40	M	40	M	40	M
4. Open 1 area	40	L	40	L	30	L	50	M	50	M	40	M	50	M	50	M	40	M	50	M	50	M	50	M
5. Open 3 areas, add	30	M	20	M	10	M	30	M	30	M	25	M	20	M	20	M	10	M	70	H	70	H	60	H
6. Open 3 areas	50	M	40	M	30	M	20	M	20	M	15	M	10	M	10	M	5	M	80	H	80	H	60	H
7. MPA open	100	H	100	H	90	H	0	M	0	M	0	M	0	H	0	H	0	H	100	M	100	M	60	M

Management scenarios are described in Table 13.2. Values assigned to each management scenario, for each objective, are shown below the weights (T0 = time zero; T5 = T0 + five years; T10 = T0 + 10 years. An H, M or L to the right of each value indicates that the authors assigned a High, Medium or Low certainty to that value).

TABLE A4 Rationales developed to assign values to each objective in the multi-criteria decision analysis.

Value	Objective
Environmental Resilience: maximise ocean health and provision of ecosystem service	
Prevent ecological scarcities	
Protect threatened linefish: species abundance (of these spp.)	
100	Pristine system, species at climax maximum abundance, older fecund individuals protected and acting as strong seed banks. No or little edge effect or migration of breeders out of area.
50	Edge effect such that large individuals spill over into opened areas, emigration and loss of older fecund individuals is doubled, with disproportionate recovery owing to slow growth rates (some species can take 30–50 years to recover).
0	Worse than currently outside the Marine Protected Area (MPA), sustained fishing pressure even at low rate causes collapse of slow-growing long-lived fish, especially when it targets the larger fecund fish. The spillover effect that is enhancing adjacent areas is lost, so these areas will be worse off.
Protect intertidal habitats: reduction of intertidal stocks, ecosystem shifts from over-harvesting	
100	Climax intertidal communities, with habitat-forming species like mussels and red-bait intact. High biodiversity and productivity, nursery areas for offshore fish species.
50	Removal of benthic habitat infrastructure species such as mussels and redbait for food and bait, shifts in spatial distribution of biotopes on the shore, reduced productivity and ability to act as seed sources to adjacent areas.
0	Same as outside MPA, collapsed stocks of important space-occupying resource species such as mussels, with concomitant loss of biodiversity. Recruitment failure owing to need for adult population presence for settlement and recovery. Need active interventions for recovery, such as reseeding.
Provide spill-over: relative abundance of target species inside and outside reserve	
100	Fish species at climax abundance, with excess numbers migrating out of the MPA to colonise adjacent areas without compromising the productivity and abundance within the MPA. Fish abundance correlated with available suitable habitat and productivity.
50	For slow-growing species all targeted fish in the opened area are depleted as they cannot withstand sustained fishing pressure. The big, old, fecund individuals (breeders) are gone owing to selective targeting of bigger fish thus reducing the stock recruitment in the area. Fishing on the edge of the adjacent closed areas has caused depletion of those areas as well, thus resulting a wider depleted area than just the open area (edge effect). This causes net reduction in abundance of the slow growing resident and big, old, fecund fish in the MPA, as well as reduction in seed stock and recruitment.
0	Worse than currently outside the MPA, because the MPA is currently providing spill-over and enhancing the stocks around it.
Reduce environmental risk	
Protect/provide refugia: size and design	
100	The whole MPA is no-take and edge effects for linefish are minimal, and habitats are not physically disturbed (by trampling etc.), and law enforcement is easier to implement.

(*Continued*)

TABLE A4 Rationales developed to assign values to each objective in the multi-criteria decision analysis.—cont'd

Value	Objective
50	The MPA is fragmented into four areas with fishing nodes at three places causing edge effects. This more than doubles the edge effects for linefish and creates access for trampling of intertidal habitats. There are no buffers between no-take and fishing areas (could be done by zonation).
0	Same as outside MPA.
Provide climate change mitigation: cumulative impacts measure/ecosystem health	
100	Healthy intact ecosystems, without stressors such as fishing and physical disturbance. Ecological and food chain complexity high which creates resilience to perturbations. Introduction of aliens and pollution minimised due to low human access (no fishing line and other litter).
50	Ecosystems more disturbed, exacerbated by edge effects from three access nodes which also bring risk of pollution and alien invasion. High risk of trophic cascades (owing to depletion of top predators) in about 25% of the inshore part of the MPA, and the disturbed intertidal habitat is now less resilient.
0	Slightly worse than currently outside the MPA, as the risk mitigation and resilience-strengthening benefits of having an MPA (healthy node) in the broader seascape is lost.
Collapse of species NB to fisheries: fisheries measures, spawner biomass (less than 20% = critical)	
100	Pristine system, species at climax maximum abundance, older fecund individuals protected and acting as strong seed banks. No or little edge effect or loss of breeders.
50	Edge effect such that large individuals spill over into opened areas, emigration and loss of older fecund individuals is doubled, with disproportionate recovery owing to slow growth rates.
0	Worse than currently outside the MPA, sustained fishing pressure even at low rate causes collapse of slow-growing long-lived fish, especially when it targets the larger fecund fish. The spillover effect that is enhancing adjacent areas is lost, so they will also be worse off.
Economic Resilience: eradicate poverty, create jobs and increase human well-being	
maximise income and Minimise cost	
Direct income to South African National Parks (SANP): reserve income (entry and accommodation)	
100	High tourism revenue, especially international.
50	Reduced tourism revenue, particularly international because the MPA is no longer marketed as large and pristine. Tourists walking in Park may encounter anglers. May be safety/security issues.
0	Tourists who want a pristine marine experience will no longer visit, but tourists will still visit for the terrestrial features of the Park.
Direct contribution to livelihoods: offset food protein bill	
100	Livelihoods enhanced by active development of small business opportunities with the claimants being the targeted recipients, that are based on nature but not extractive. Benefit from international tourist trade. Sustainable tangible benefits from the MPA.
50	No injection of funds from government to develop alternative livelihoods for claimants. The fishing brings limited additional financial assistance, as it is not commercial and thus just provides food. But

TABLE A4 Rationales developed to assign values to each objective in the multi-criteria decision analysis.—cont'd

Value	Objective
	perhaps anglers can get permission to market fishing excursions for tourists and can act as guides using the additional access points.
0	Worse than currently outside as now no MPA to get tourism revenue from, and no spill-over.
Indirect income (local area income via e.g. employment opportunities, trade): local economic statistics	
100	Employment opportunities for tourism maximised. Alternative livelihood jobs created.
50	Employment from tourism linked to the MPA is available, but there is not growth in jobs through alternative livelihoods development.
0	Worse than currently outside as now no MPA to get tourism revenue from, and no spill-over.
Indirect income (contribute to international tourist revenue i.e. national tax base): National & SANP economic statistics	
100	International tourism maximised as the MPA is marketed as the longest and biggest no-take MPA in Africa. Pristine coastline.
50	Reduced international tourism, deflected to Cape Point and iSimangaliso where large no-take areas maintained. Safety and security risk perception when tourists encounter anglers in remote locations is a consideration.
0	No international tourism from tourists who wish to visit a pristine and protected marine environment, and many paths down to the shore with anglers, litter and security issues. Tourists go to other no-take MPAs.
Minimise management/compliance costs (to SANP): SANP management costs	
100	Large cohesive area is easier to manage than an area broken up into areas of fishing and no-take. Thus, less resources for patrolling are needed. Developing alternative livelihoods for the claimants reduces the poaching pressure, further reducing costs of compliance.
50	Significant additional law enforcement effort required as more access to the MPA. People walking along the shoreline now need to be checked to see if they are just hikers or are fishing, and whether they have a permit or not. In addition, research and monitoring costs go up, to assess impacts and sustainability.
0	No costs incurred by SAPARKS as they are no longer MPA Management authority, but the Department of Agriculture, Forestry and Fisheries (DAFF) will need to do law enforcement based on fisheries regulations for bag limits and fish sizes.
Equity: maximise social acceptability	
Customary rights	
Restore customary rights of local resource users: potential to restore traditional rights	
100	Access to exercise traditional resource harvesting is available throughout the MPA
50	Access to exercise traditional resource harvesting is limited to only one node in the MPA
0	Any rights to unrestricted customary traditional resource harvesting within the MPA are not recognised or accommodated.

(*Continued*)

TABLE A4 Rationales developed to assign values to each objective in the multi-criteria decision analysis.—cont'd

Value	Objective
Proximity rights	
Provide access to local recreational anglers: potential to achieve this goal	
100	Recreational anglers proximal to the MPA have access to all areas.
50	Recreational anglers have access to a fishing node within the MPA, benefiting from spill-over edge effects.
0	Recreational anglers have no access to fishing areas within the MPA (no-take MPA).
National rights (Constitution)	
Bill of Rights (Chapter 24): potential to achieve this goal	
100	No-take MPAs are an essential element of marine spatial planning to achieve goals for ocean health and are an important tool in a blue economy that ensures protection of marine ecosystem services, including resilience to climate change and provision of food security.
50	Ecosystem services derived from the current large no-take area are compromised including sense of place, global significance of the site, climate resilience, international tourism attraction, and the fishery support function for the broader ocean area is reduced.
0	The coastline and ocean inside the MPA become degraded with pollution and fishing. The MPA is no longer a national asset that is recognised internationally.
Evidence-based (knowledge-based) decisions: application of social knowledge of local community	
100	Adjacent communities fully support the MPA and are involved in co-management processes and derive direct benefits. Social knowledge is shared and respected and incorporated in the objectives of the MPA without compromising the protection levels for the natural assets for which the MPA has been proclaimed. No proposed management action scenario reaches this status because a co-management option has not been proposed by the Park authority.
50	Adjacent communities derive recreational and tourism benefits from the area despite it no longer being an MPA, through engagement with the authority of the terrestrial part of the Park.
0	Adjacent communities do not support the MPA and are confrontational and are not involved in any co-management processes. Social knowledge is not shared and respected or incorporated in the objectives of the MPA.
Evidence-based (knowledge-based) decisions: application of scientific knowledge of the resource	
100	The MPA is managed actively and has defined ecological objectives which are used to monitor management effectiveness in an adaptive management process. Scientific monitoring and studies are conducted within the MPA and receive funding from the MPA Management Authority. The scientific results are incorporated, resulting in no open areas, given the evidence that opening parts of the MPA will compromise the key objective for conservation of endangered linefish species.
50	The MPA is managed actively and has ecological objectives defined which are used to monitor management effectiveness in an adaptive management process. Scientific monitoring and studies are conducted within the MPA and receive funding from the MPA Management Authority. However, the scientific knowledge about the importance of a large no-take area without internal edge effects

TABLE A4 Rationales developed to assign values to each objective in the multi-criteria decision analysis.—cont'd

Value	Objective
	caused by opening a fishing node, has been disregarded, thus failing to meet an important objective of the MPA (protection and recovery of endangered linefish species).
0	Scientific knowledge is disregarded for a major objective of the MPA, i.e. the recovery and protection of endangered linefish species, resulting in depletions and removing the seed stock that was sustaining surrounding fisheries.
Equity: maximise political gain amongst stakeholders	
Municipal	
Municipal buy-in and support for the Park: assume that priorities are not environmental	
100	Municipality gains maximum political support during the municipal by-elections, because it made an election promise to gain fishing access to the MPA.
50	Municipality gains moderate political support during the municipal by-elections through the opening of the 3 areas to fishing, because it made an election promise to gain fishing access to the MPA. People wearing political insignia are evident during the community protests.
0	The Local Municipality gains no political support derived from the Tsitsikamma matter, possibly getting negative publicity because they are seen as lacking in influence in national political circles.
National	
Supporting national goals (buy-in from parliament): assume priorities for environment more important	
100	National government is applauded for standing firm on national development goals and following due process similar to that applied in the lands claim process where claimants have to show a historical right; and when rights are awarded, the conservation status of an area is not changed. Rather a co-management agreement is entered into with the claimants and compensation is given with ongoing benefits from the MPA flowing to the claimants and their families.
50	National government is cautiously commended for balanced handling of a matter that had become a political hot potato, i.e. standing firm on national development goals by allowing opening of only 1 node, while giving recognition to the local community by giving them limited access. However, national government also attracts negative sentiment due to this being the oldest no-take MPA in the country, and the need for the protection of the endangered linefish species.
0	National government is criticised heavily by other political parties and the public in general, as it is perceived that a national asset has been given away to local recreational anglers for little gain to them, and that it is not serious about global commitments that the country has committed to
International	
International accolades or negative perception of South Africa: assume priorities for environment even more important	
100	South Africa is applauded at international forums such as UNEP and the African Union for being a leader with regards meeting global targets for protection of the oceans, while paying attention to redressing human rights.
50	The South African government is cautiously commended for balanced handling of a matter that had become a political hot potato, i.e. standing firm on achieving global targets for ocean protection,

(*Continued*)

TABLE A4 Rationales developed to assign values to each objective in the multi-criteria decision analysis.—cont'd

Value	Objective
	while giving recognition to the local community by giving them limited access. However, national government also attracts negative sentiment due to this being the oldest no-take MPA in the country, and the need for the protection of the endangered fish species, and the fact that principles were compromised for recreational (not food security) reasons.
0	The South African government is criticised by global leaders for rolling back protection of the oceans at a time when the importance of MPAs has been internationally recognised as a key tool for ensuring healthy oceans and resilience to climate change. This is contrary to the to the SDG14 target to which South Africa is signatory and such an action would no doubt attract attention in the international press.
Party partisan pressure	
Ruling party leverage in meetings: party-partisan pressure on decision maker	
100	Decision-maker gains maximum political leverage with the political party in power, using it to further career steps within government.
50	Decision-maker maintains support and political cover from ruling party by conceding to demands of the community, but does not compromise completely, and either opens only one area or keeps the MPA closed and gives the community compensation.
0	Decision-maker makes an objective, evidence-based decision, in line with existing government legislation and agreements, and is not influenced by political pressure.

Rationales are provided for values of zero, 50 and 100 (i.e. minimum, median and maximum possible values respectively), but values anywhere between these can be assigned, using these three values as a guide.